

JSC-20052
VOLUME 6

SPACE SHUTTLE PAYLOAD

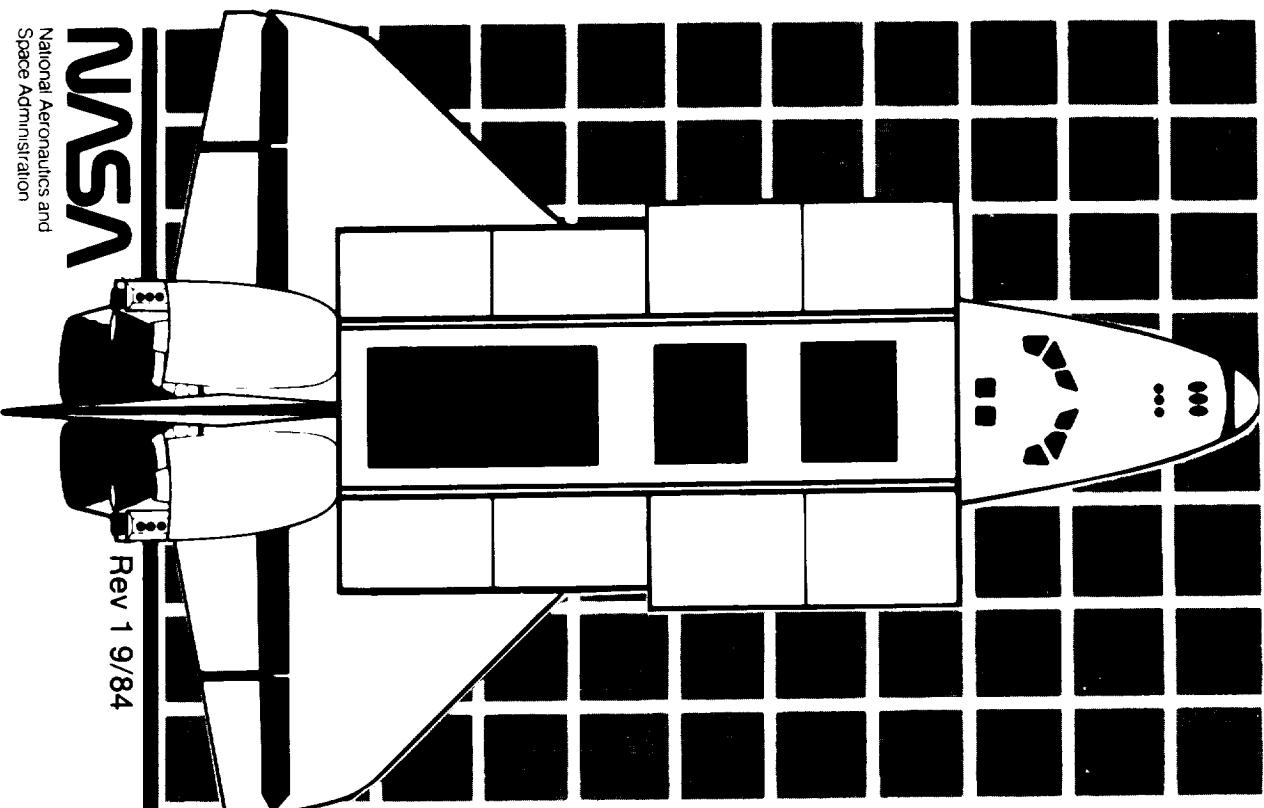
DESIGN AND DEVELOPMENT

(NASA-TM-108230) SPACE SHUTTLE
PAYLOAD DESIGN AND DEVELOPMENT.
VOLUME 6: MISSION OPERATIONS
INTERFACES (NASA) 50 p

N94-70370

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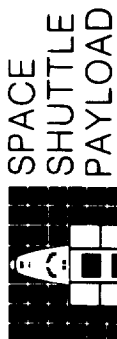


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NASA

National Aeronautics and
Space Administration
Lyndon B. Johnson Space Center

MISSION OPERATIONS INTERFACES



DESIGN AND DEVELOPMENT

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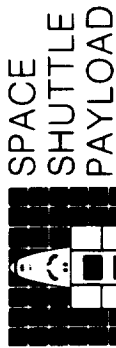
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PAYLOAD MISSION OPERATIONS PROCESS

The development of the various mission operating interfaces is an iterative process which involves both the customer and NASA. NASA uses the customer requirements detailed in the PIP and its annexes to develop a basic version of all the tools used for training and for execution of the flight. The Payload Operations Working Groups (POWG's) are used to review the customer requirements and to resolve any issues during the development process. The basic products are reviewed by the customer and NASA at the Flight Operations Review, typically scheduled 3 months prior to launch. Any changes will be reflected in the final set of products, which are used for the flight.

The Payload Officer at the Johnson Space Center is the customer point of contact in the POWG process. In this capacity, the Payload Officer can guide the customer in fulfilling their responsibilities and assist in the development of the appropriate mission interfaces. The Payload Officer will also act to ensure that the appropriate JSC disciplines can support customer requirements.



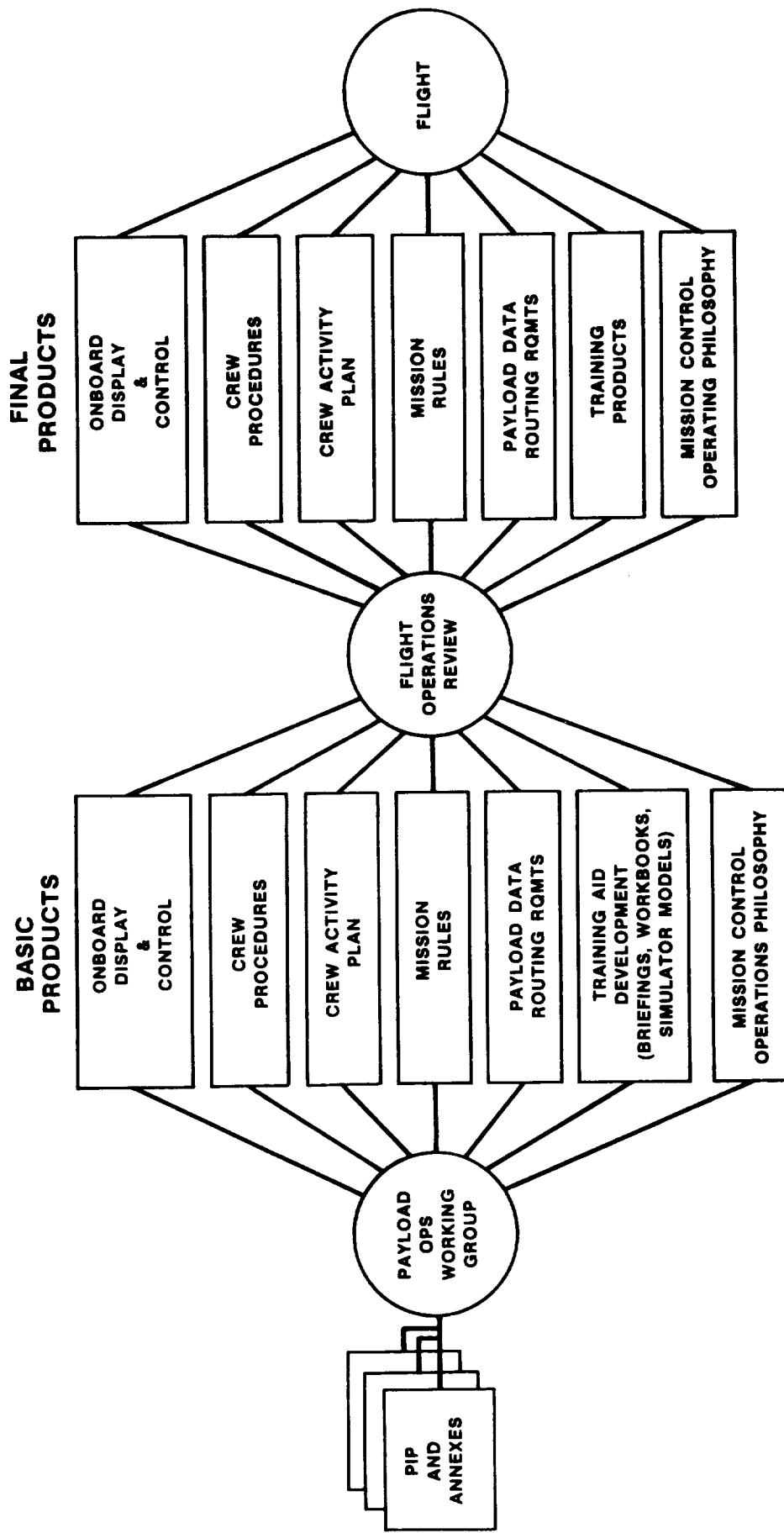
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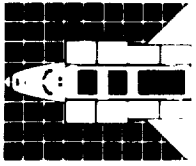
MISSION OPERATIONS PROCESS

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MISSION OPERATIONS PRODUCTS

- Onboard Display and Control - NASA uses the information provided in the Command and Data Annex and the Crew Compartment Annex to configure Orbiter computer displays and panels for the crew to accomplish payload objectives.
- Crew Procedures - The Flight Operations Support Annex (#3) provides the customer requirements for crew procedures. NASA will translate these procedures into the Flight Data File (FDF) standards, which are used for flight. The finished procedures will be provided to the customers for review.
- Crew Activity Plan - The Flight Planning Annex (#2) provides the customer requirements for the allocation of crew time. This information is used to develop the overall mission crew activity plan.
- Mission Rules - Permission the NASA control team identifies as many decision points as possible. The customer is requested to provide inputs in Annex #3 that identify potential failures and the appropriate course of action for each failure.
- Payload Data Routing Requirements - NASA has the capability to route various types of Shuttle and payload data to remote locations for customer convenience. Once the data types and routing locations are identified the proper interfaces will be exercised several times prior to flight.
- Training and Development - In order to train the NSTS flight crew and mission control team to properly accomplish the payload objectives, NASA must develop several training aids. Those training aids include briefings, workbooks, and simulator models. NASA uses this data available in the PIP and annexes to develop these tools.
- Mission Control Operating Philosophy - The Payload Officer is the NASA mission control team representative for all customer activities. The Flight Operations Support Annex should contain the customer's plans for interfacing with the Payload Officer to ensure the customer's participation in mission activities.



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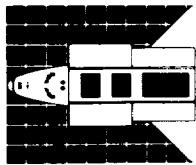
PAYLOAD MISSION OPERATIONS

PRODUCTS

- **ONBOARD DISPLAY AND CONTROL**
- **FLIGHT SOFTWARE**
- **CREW PROCEDURES**
- **CREW ACTIVITY PLAN**
- **MISSION RULES**
- **PAYLOAD DATA DISTRIBUTION**
- **TRAINING**
- **MISSION CONTROL OPERATING PHILOSOPHY**

ONBOARD OPERATIONS

The overall area of operations can easily be divided into onboard operations and ground control team operations. The first portion of this presentation will concentrate on the details of onboard operations. The individual areas which will be discussed include standard switch panel use, GPC software for data display, GPC command capability and fault detection, crew procedures, crew timelines, and training.



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ONBOARD OPS CONCEPT DISPLAY AND CONTROL

CREW OPERATIONS

CREW PROCEDURES
(FLT OPS SUPPORT)
ANNEX 3

CREW TIMELINES
(FLIGHT PLANNING)
ANNEX 2

CREW TRAINING
(VARIOUS DATA USED
FOR MODEL
DEVELOPMENT)

ONBOARD
OPS
CONCEPT

GPC DATA DISPLAY
(COMMAND AND DATA)
ANNEX 4

GPC COMMANDS
(COMMAND AND DATA)
ANNEX 4

FAULT DETECTION
AND ANNUNCIATION
(COMMAND AND DATA)
ANNEX 4

STANDARD SWITCH
PANEL
(CREW COMPARTMENT)
ANNEX 6

DISPLAY AND CONTROL

Standard Switch Panel (SSP)

The Crew Compartment Annex (annex 6) is the document which details the use and nomenclature of each payload allocation of various Orbiter switch panels. Although some other panels are available for very specific purposes, the primary interface for payloads is the standard switch panel. The customer is responsible for providing initial inputs for the use and nomenclature of all the switches and talkbacks they intend to use. These inputs are then reviewed by JSC crew, engineering, and mission operations personnel and any recommendations or desired changes are negotiated with the customers.

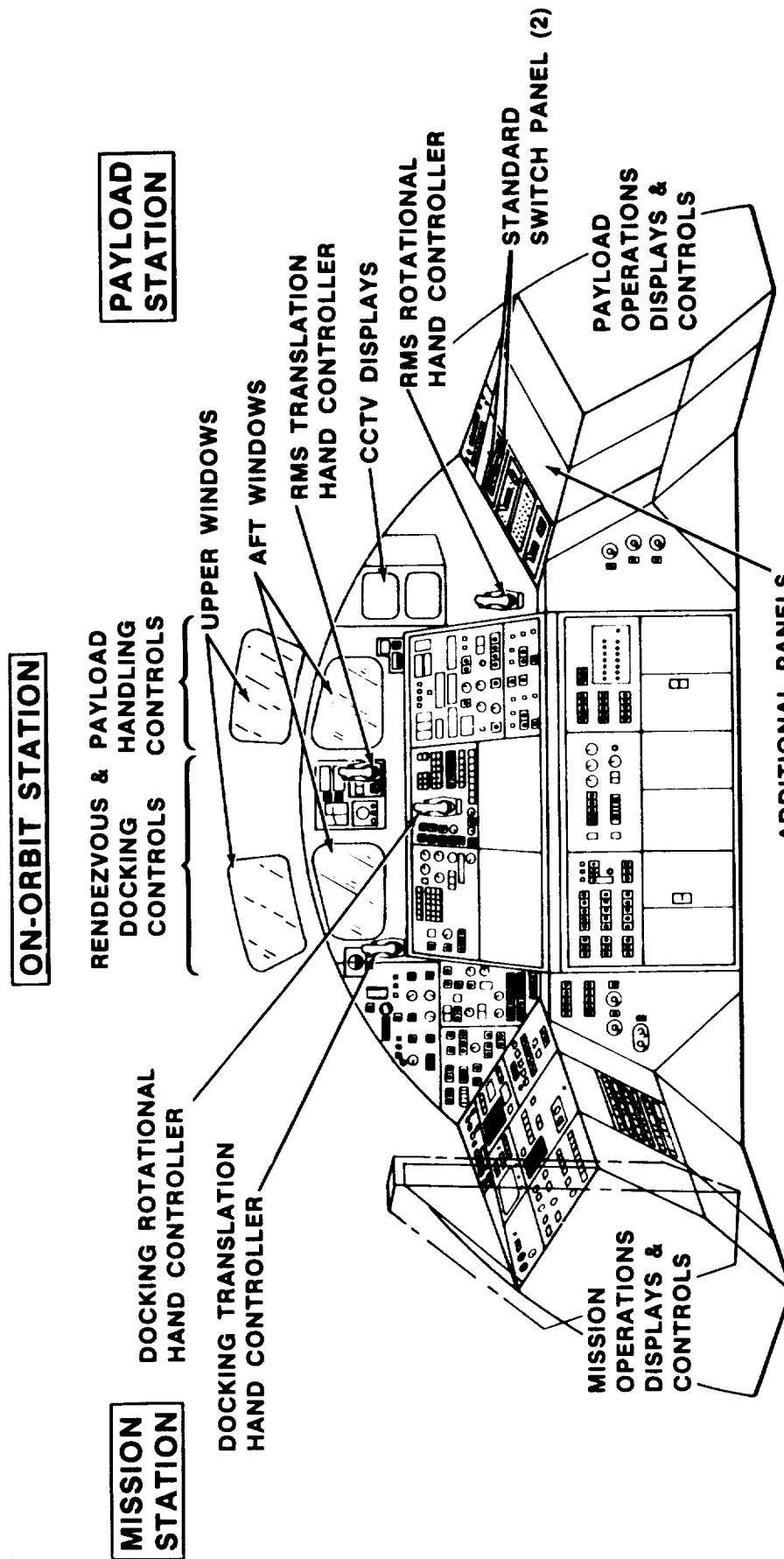
Any customers utilizing their own unique panels should be aware that additional panels may be required for use in training and integration.



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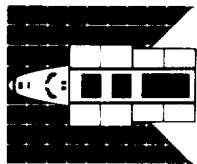
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ORBITER INTERFACES WITH PAYLOADS AFT FLIGHT DECK



VIEW LOOKING AFT

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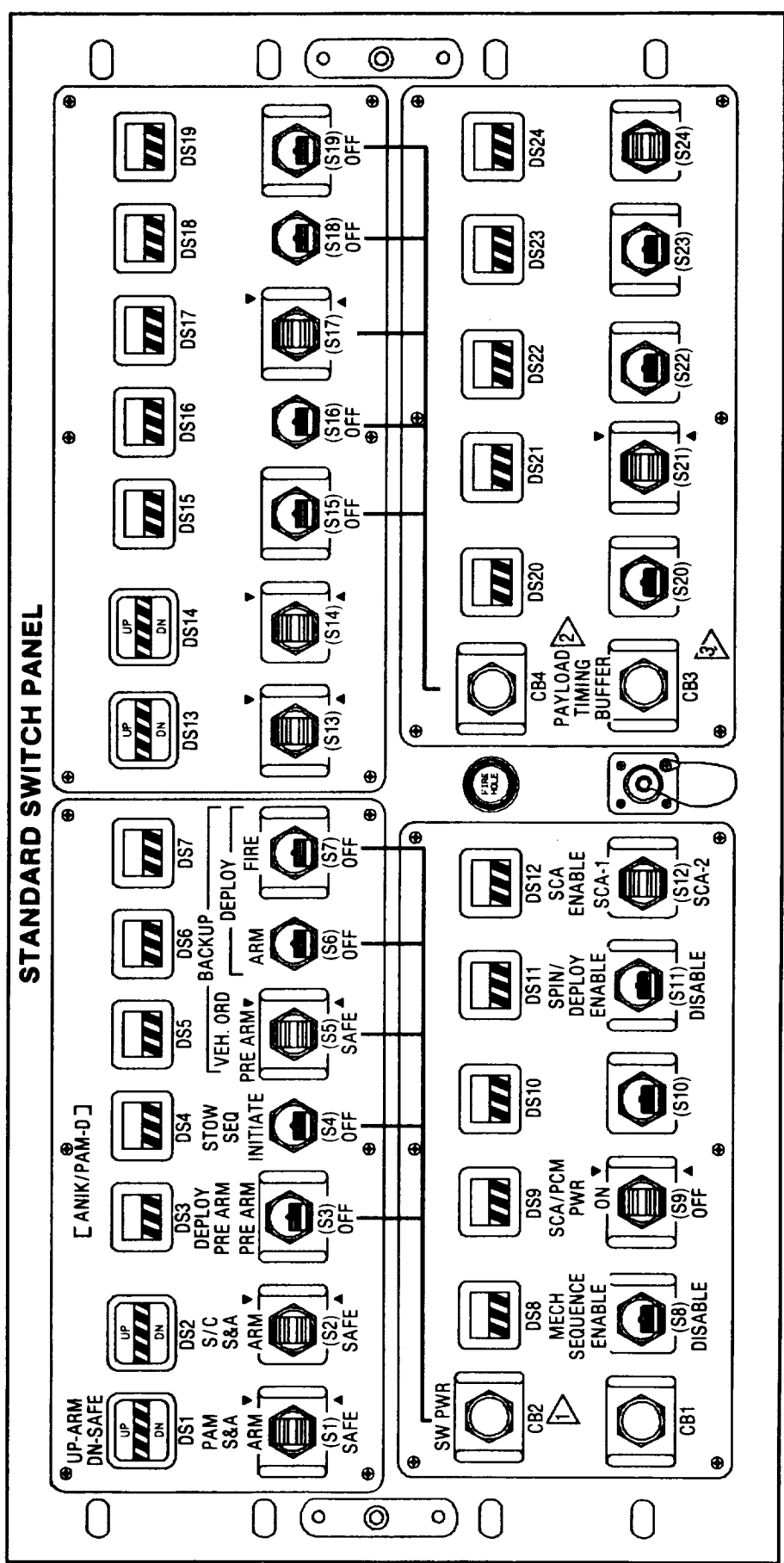
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TYPICAL STANDARD SWITCH PANEL

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PANEL L12



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DISPLAY AND CONTROL (Cont)

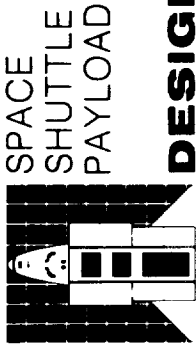
GPC Display and Commands

The Orbiter General Purpose Computers (GPC's) have the capability to display data from and transmit commands to payloads. The Command and Data (C&D) Annex (annex 4) is used by the customer to specify the parameters available for display and the commands required for the payload operation.

JSC will use the C&D annex inputs as a guide in formatting the actual GPC displays with the proper data and commands to be used by the crew. Once the first draft of the displays is available, JSC will review them with the customers to ensure that all customer requirements have been met.

In addition to the display capabilities, the GPC can also be used to alert the crew to out-of-limits or potentially hazardous conditions. This system is designated as the Fault Detection and Annunciation (FDA) system. The customer should provide a list of the parameters which should be annunciated but should not attempt to provide the precondition steering logic which is used to determine the appropriate sets of limits for each parameter. JSC will formulate the precondition steering logic and will schedule a review with the customers to ensure that the proper logic is used.

All of the GPC software requirements from the C&D annex and display development will be documented by JSC and will be available to be baselined at the Integrated Hardware/Software Review.



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TYPICAL PAYLOAD DISPLAY

XXXX/XXX/		(S/C NAME)	DEPLOY	XX X	DDD/HH:MM:SS
DPLY X		XXX/XX:XX:XX	SCA CLK X	XXXX	DDD/HH:MM:SS
		COUNTDOWN XX: XX:XX			
ITM	EVENT	SCHD	CPLT		
1	COUNTDOWN START		XXXX	XXX XXX XXXX	
2	MECH SEQ START		XX	M1 CUR	M2 CUR
	SUNSHIELD OPEN		XS	X.XX	X.XX
	STBD RSTRNT OUT		XS	X.XX	X.XX
	PORT RSTRNT OUT		XS	X.XX	X.XX
SSP	MECH SEQ DISABLE		XS		
SSP	SPIN ENABLE		XS		
3	SPIN XXX.XS XXX.X		X	XX.X	XX.X
	TERM SEQ START	3:00	X		
	VEH ORD PREARM	1:30	X		
SSP	PAM S&A		XS		
	DEPLOY PREARM	:30	X		
	DEPLOY ARM	:05	X		
	DEPLOY FIRE	:00	X		
P/L DEPLOYED X/X 5 RESET 4 DEPLOY INH X					

CREW OPERATIONS

Crew Procedures

The customer is responsible for providing an initial input for crew procedures as a part of the Flight Operations Support Annex (annex 3). Based on the annex inputs, JSC will develop the actual crew checklists which are part of the Flight Data File (FDF) used for the actual execution of the mission.

The development of the FDF is generally timed to crew training and mission preparation milestones. Once these documents are available, the customer has an opportunity to review and comment on the documents. This review is accomplished formally as a Flight Operations Review (FOR) which is scheduled 2-3 months prior to launch.

Crew Timelines

All of the required payload activities must be specified in the Flight Planning Annex (annex 2). These activities will be integrated by JSC with other payload activities and all the activities required for Orbiter operations. The resulting timeline is referred to as the Crew Activity Plan (CAP) and is available for review at the FOR.



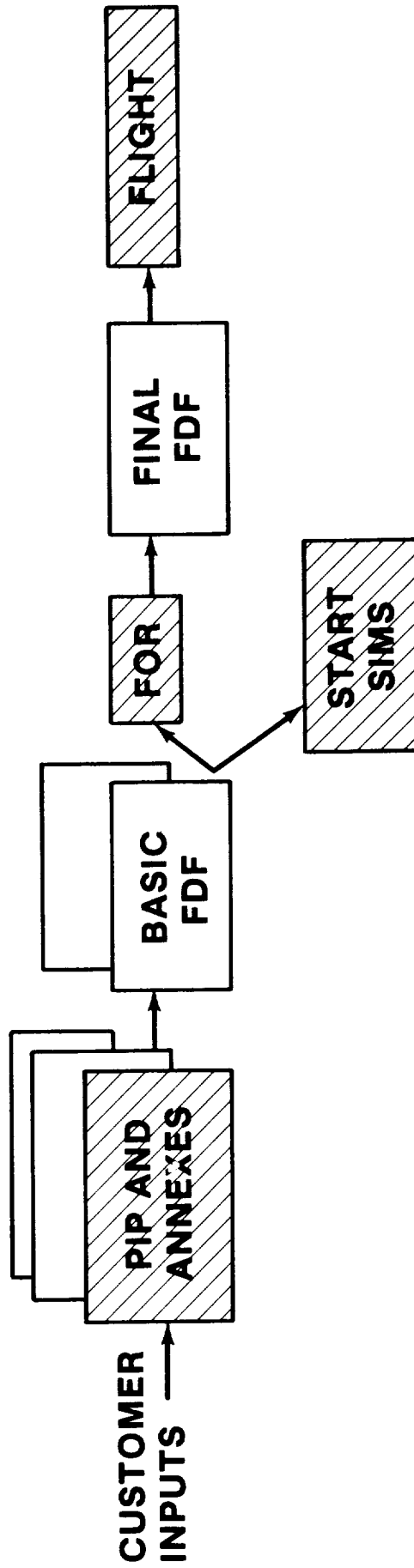
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CREW OPERATIONS

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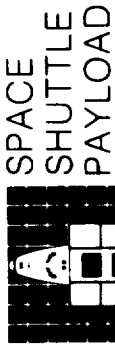
- JSC FORMULATES FLIGHT DATA FILE FROM ANNEX INPUTS
- CUSTOMER REVIEW AT FLIGHT OPERATIONS REVIEW (FOR)
- FLIGHT DATA FILE USED FOR SIMULATIONS AND FLIGHT

CREW OPERATIONS(Cont)

Crew Training

Crew training is actually accomplished by several means including workbooks, classes, briefings, trainers, and simulators. In many cases, training for payload operations may also include visits to a customer's headquarters to provide an understanding of the mission objectives and an opportunity to view actual hardware.

Much of the actual crew training is accomplished using the NASA Shuttle Mission Simulator (SMS). This simulator can be used either "stand alone" with just a team of instructors or in an integrated mode with the Mission Control Center (MCC). For each payload, JSC will provide a Generalized Payload Model (GPM) which will model the appropriate payload commands and data flow to allow the crew increased fidelity for training. The data used to develop these models is taken from several sources including safety packages and several annexes.



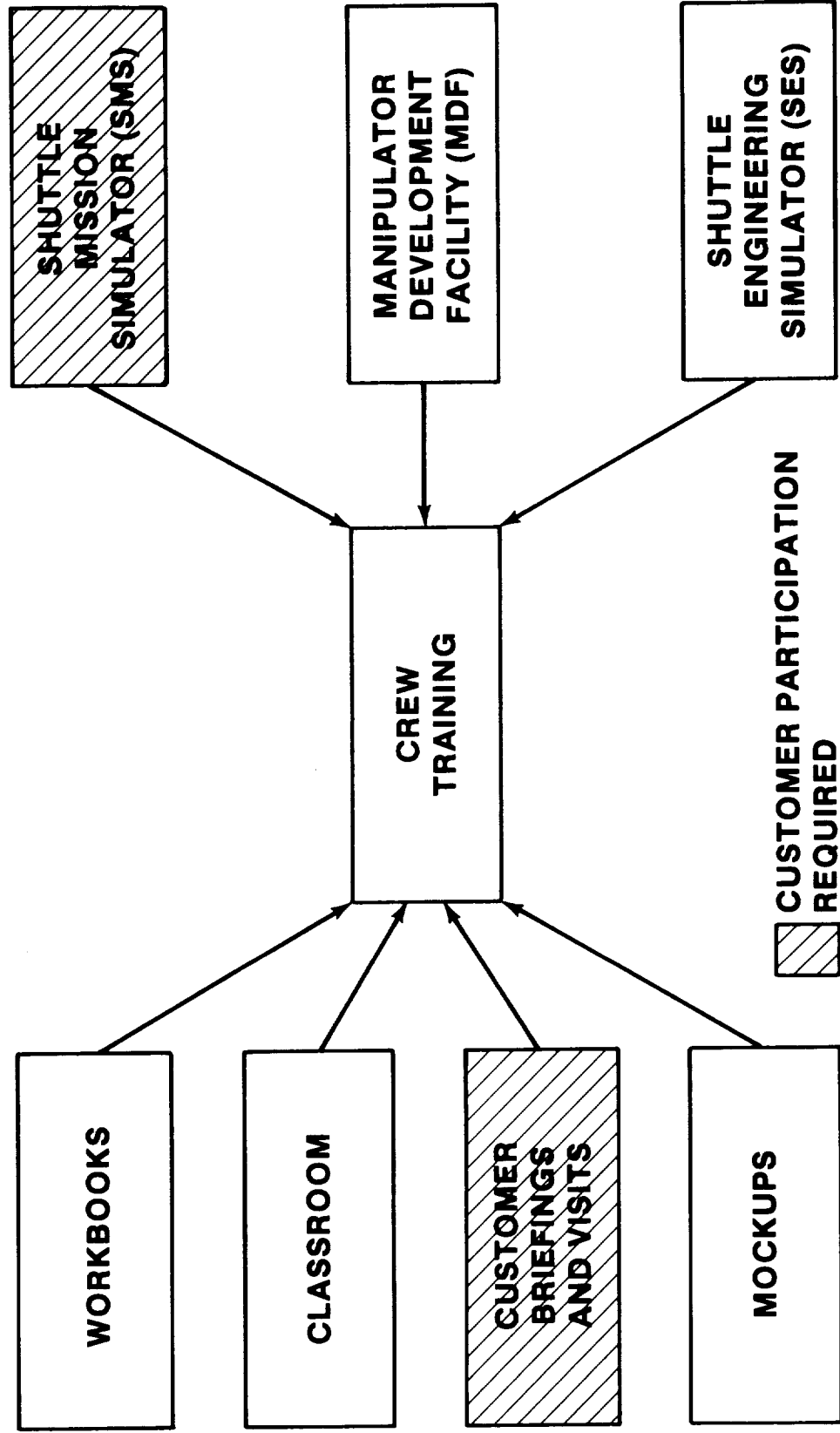
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CREW TRAINING OVERVIEW



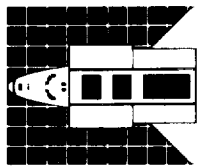
MISSION CONTROL OPERATIONS

Just as the onboard operation is comprised of several disciplines, the mission control operation is also built from several different areas. Each customer must develop an operations philosophy which details the responsibilities of customer personnel at JSC and/or a remote Payload Operations Control Center (POCC) and their interfaces with the NASA control team. Any procedures which govern the transfer of data between the Mission Control Center (MCC) and the remote POCC must also be developed and documented premission.

Some payloads require operation from the MCC by commands routed through the Orbiter. The ground operating procedures for these activities must also be developed and exercised premission.

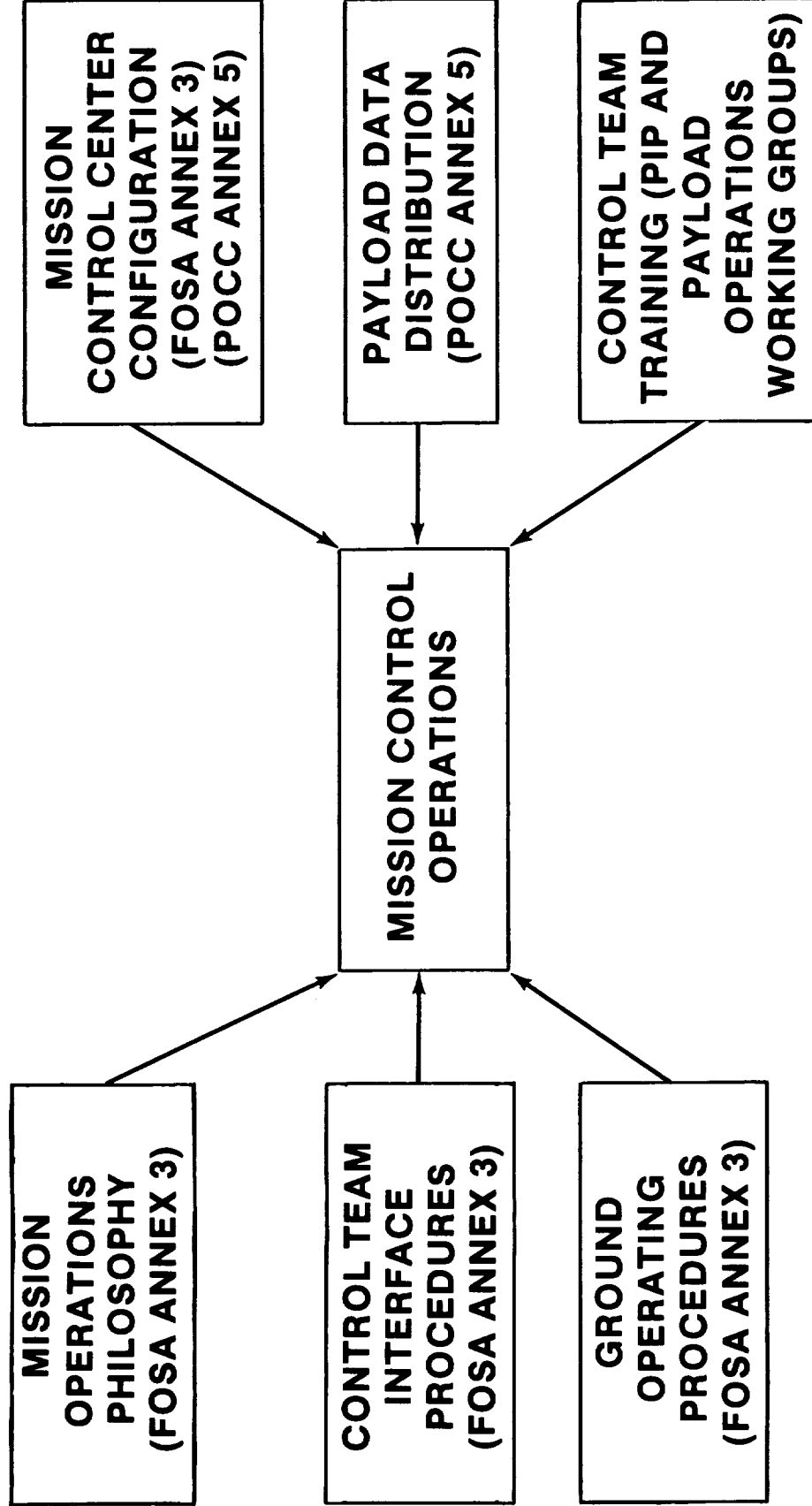
Most customers have at least one representative at the MCC during the flight. This representative may provide support from the payload Multipurpose Support Room (MPSR) or the Customer Support Room (CSR). For each flight, JSC reconfigures these customer-unique areas. In addition to the customer support at JSC data can be routed to remote locations. Through the POCC annex (annex 5) JSC determines the types of data to be routed and the remote locations which are to receive data. These data and voice lines are all configured and tested prior to the flight.

The final area of concern is the control team training. This training effort consists of briefings and simulations. The simulations entail a fully manned Mission Control Center receiving data from the Shuttle Mission Simulator and crew and transmitting that data to remote customer locations. These simulations will normally involve customers in 6 to 10 hour sessions rehearsing various mission events. Simulations will usually begin two months prior to launch.



MISSION CONTROL OPERATIONS

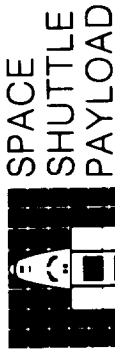
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FLIGHT OPERATIONS SUPPORT OVERVIEW

The NASA Flight Director is responsible for all of the real-time operations of the flight. He is supported by several flight control officers specializing in various Orbiter systems. The customer representative on the flight control team is the Payload Officer. He and his team are responsible for collecting and coordinating all payload recommendations to the Flight Director.

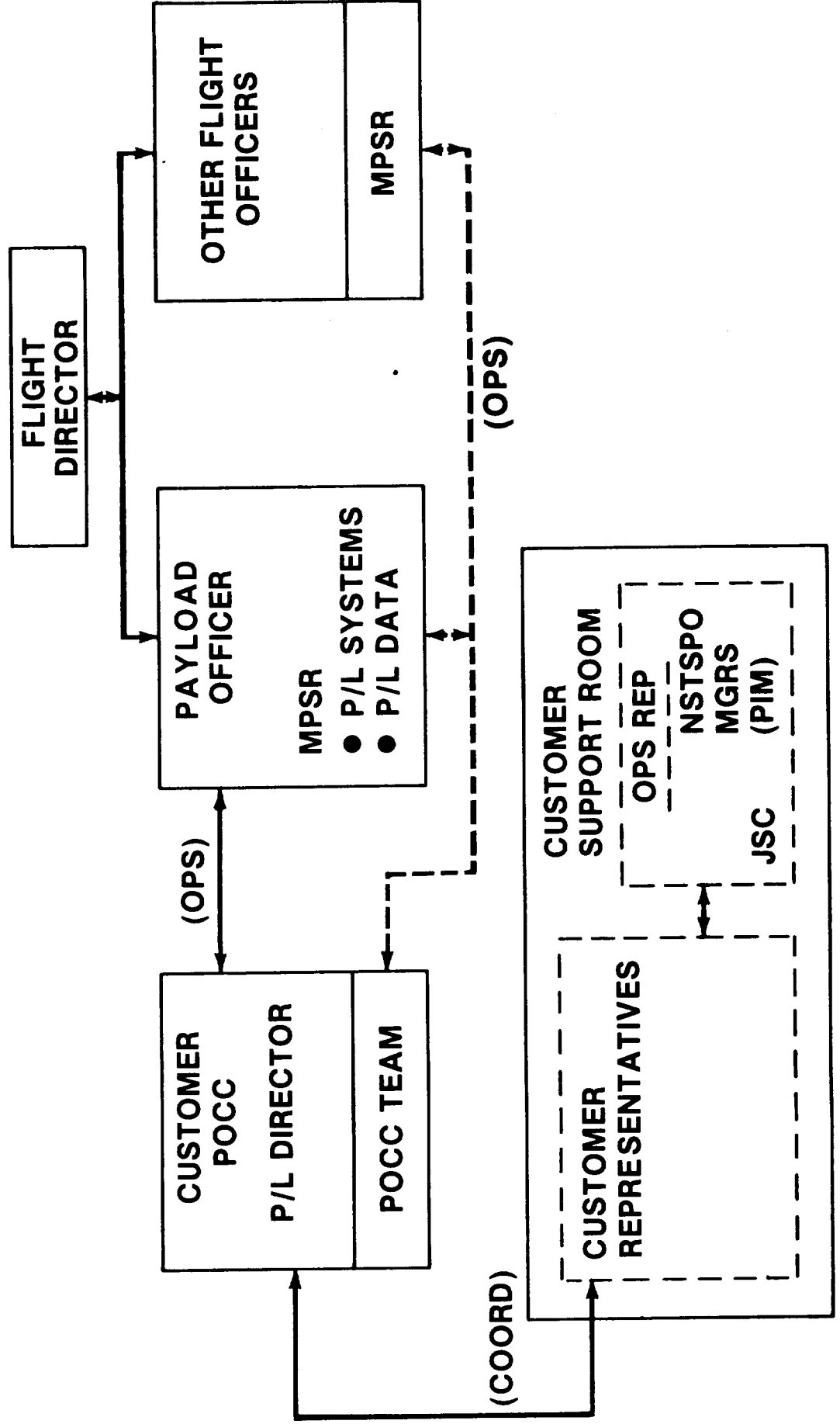
During times of mission anomalies, another NASA team located in the Customer Support Room (CSR) is available to help prioritize the payload objectives and to define mission options. This team then can recommend those changes to the flight control team. The customer can support the flight from a remote Payload Operations Control Center (POCC), the JSC P/L Multipurpose Support Room (MPSR), or the Customer Support Room.



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FLIGHT OPERATIONS SUPPORT OVERVIEW



MISSION CONTROL OPERATIONS (Cont)

Control Team Interface Procedures

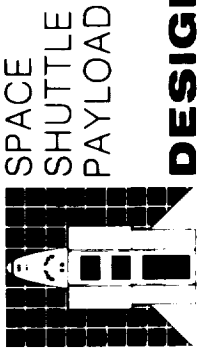
JSC will provide a selection book of procedures which detail the interface between the JSC flight control team and the customer team. These procedures generally outline the JSC/customer decision making process and provide the requirements for the various data products available in the Mission Control Center (MCC). Each customer selects the applicable procedure from the selection book and adds any unique procedures which are required.

Ground Operating Procedures

Some payloads will require commands from the MCC for either normal operation or troubleshooting in the event of malfunctions. These procedures should be provided as part of annex 3 and will be reviewed by NASA and the customer.

Mission Control Center Configuration

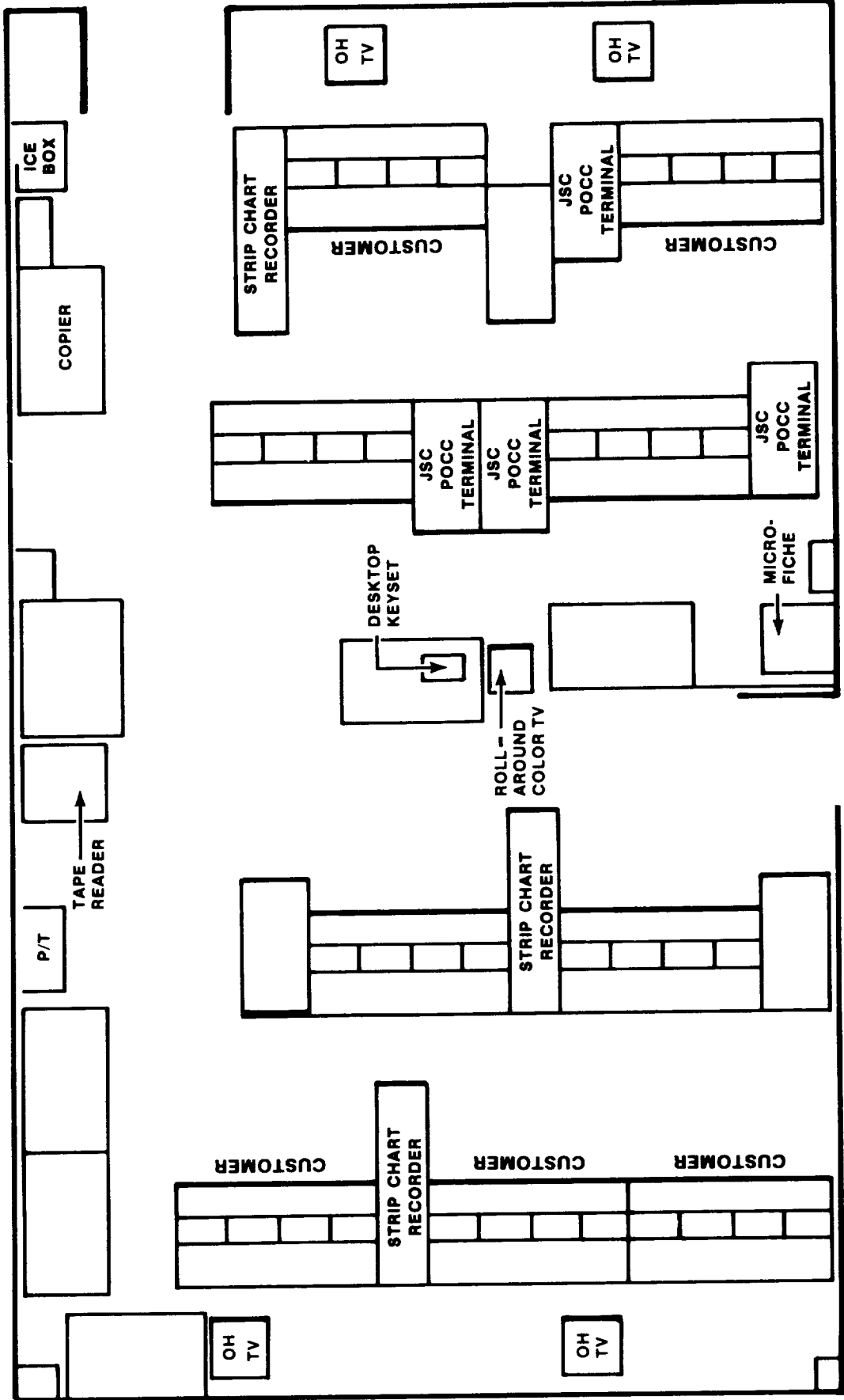
JSC has a limited capability to house customer representatives in the MCC for mission support. The two areas generally used for customer support are the payload Multipurpose Support Room (MPSR) and the Customer Support Room (CSR). Both of these areas provide access to Orbiter data displays and the voice communication network. Any unique requirements for personnel in the MCC will be documented in the Payload Operation Control Center (POCC) annex 5. Information concerning the expected level of customer support in the MCC should be included in section 2 of the Flight Operations Support Annex (FOSA).



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PAYLOAD MPSPR ROOM 217

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MISSION CONTROL OPERATIONS (Cont)

Payload Data Distribution

The POCC capabilities document (JSC 14433) describes the various data services which can be provided by the MCC. The POCC annex is used in conjunction with the POCC Capabilities Document to define the customer requirements for data products. The JSC annex manager can be of assistance in defining typical data services for similar payloads.

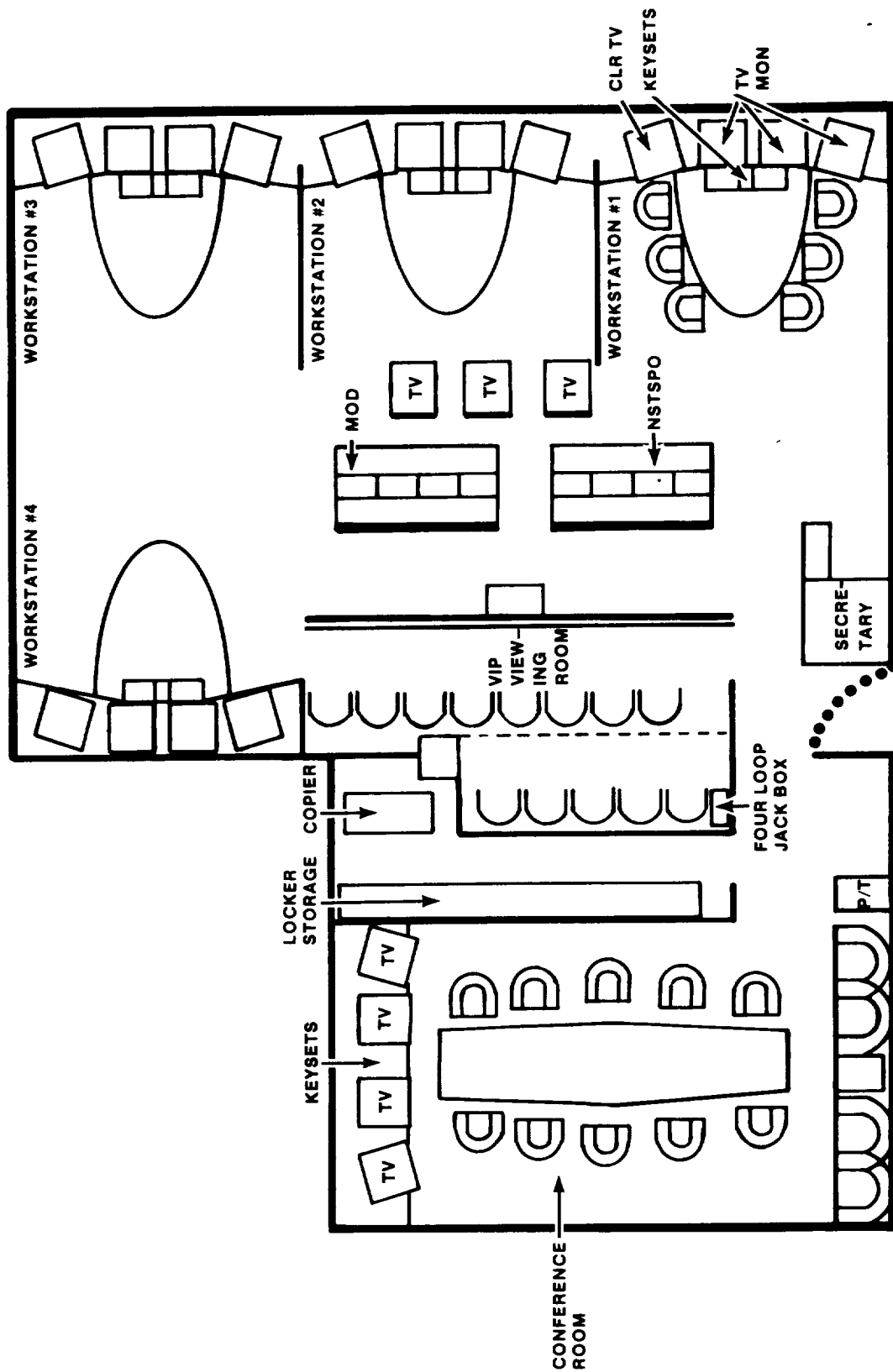
Once the data products are defined, annex 3 should be used to define the times that these products are required during the flight.



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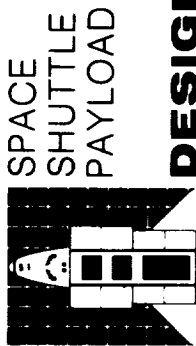
CUSTOMER SUPPORT ROOM 236



MISSION CONTROL OPERATIONS (Cont)

Control Team Training

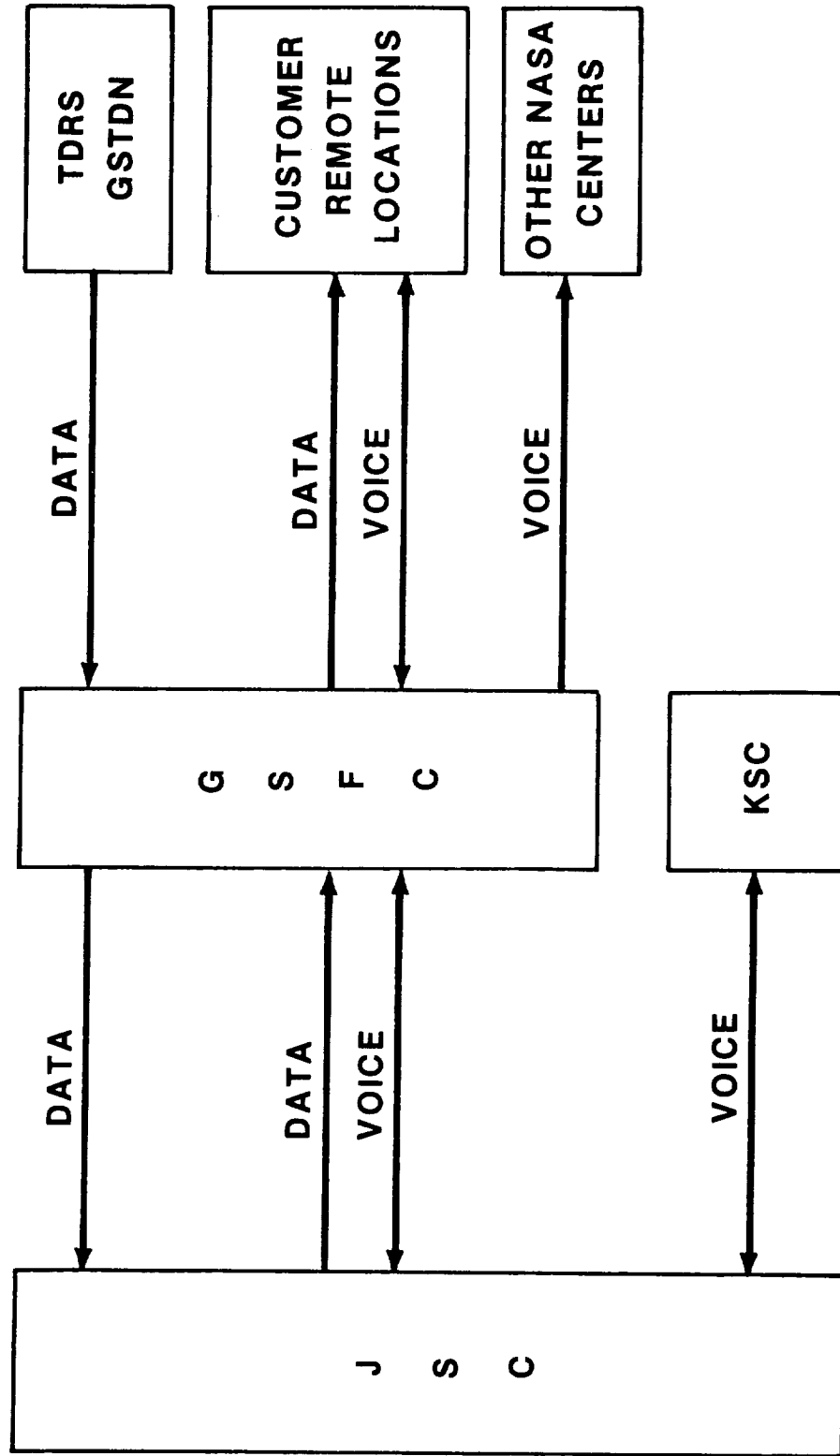
In addition to familiarization briefings provided by the customers, NASA also requires customer participation in integrated simulations prior to flight. These simulations are the primary training tool for the flight control team and involve the crew, the shuttle mission simulator, and the MCC. Typically, simulations begin 6 to 8 weeks prior to flight and are used to exercise all of the flight documentation. JSC encourages customer participation as much as possible and also encourages customers to monitor simulations prior to their flight.

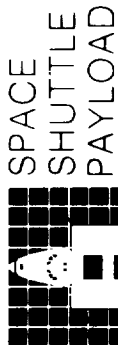


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TYPICAL PAYLOAD DATA DISTRIBUTION

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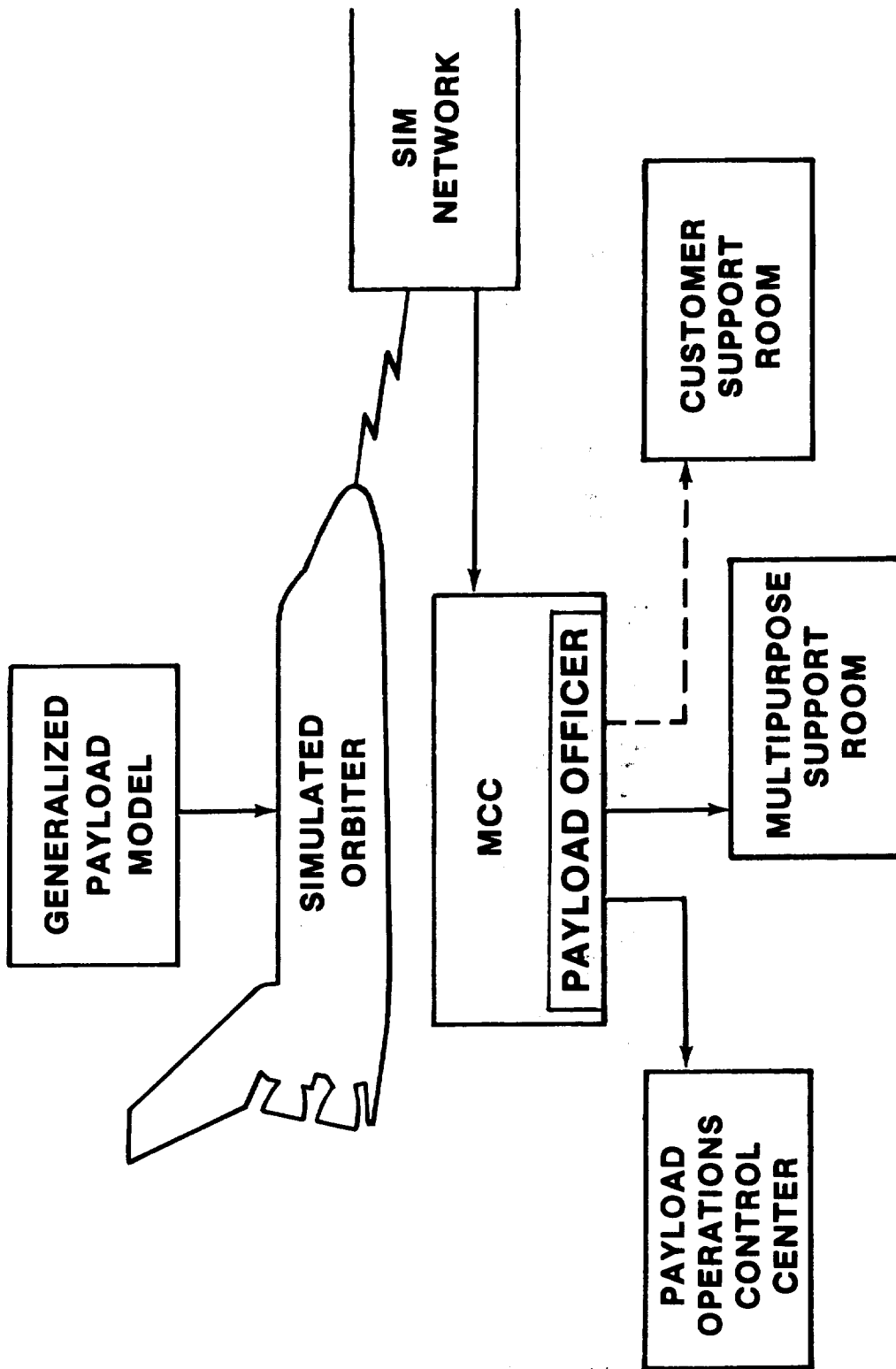




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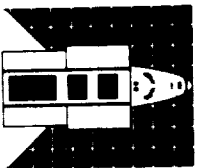
TYPICAL PAYLOAD DATA DISTRIBUTION

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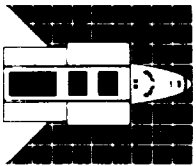
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RECOMMENDATIONS

- **USE DEVELOPED CAPABILITIES**
 - **PAM, IUS AND PALLET OPERATIONS ARE BECOMING STANDARDIZED**
 - **REMOTE MANIPULATOR SYSTEM (RMS) DEPLOYMENTS WILL SOON BECOME STANDARDIZED (LDEF, SPARTAN, ERBS)**

OR

- **TARGET DESIGN FOR A SIMPLE CREW INTERFACE**
 - **A NONCOMPLEX BUT WELL DESIGNED CREW INTERFACE REDUCES TRAINING, CHECKOUT, AND DOCUMENTATION COST**
 - **PROVIDE THE CREW WITH ENOUGH DATA TO DO THE TASK, BUT MAKE USE OF POCC DATA TO AVOID EXTENDED CREW OPERATIONS**



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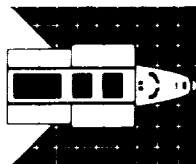
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RECOMMENDATIONS (CONT)

- TRY TO AVOID IRREVERSIBLE DEPLOY SEQUENCES
 - ANTENNA DEPLOYS
 - UMBILICAL RETRACT
- MAXIMIZE FLEXIBILITY BY BEING COMPATIBLE WITH REQUIRED ORBITER ACTIVITIES
 - WATER DUMPS
 - FUEL CELL PURGES
 - FLASH EVAPORATOR OPERATIONS
- MAKE USE OF STANDARD CONTROL TEAM INTERFACES
- PROVIDE DUAL COMMUNICATIONS OUTSIDE U.S.
 - THE PROCEDURES TO INTEGRATE OPERATIONS BETWEEN JSC AND REMOTE POCs HAVE BEEN DEVELOPED AND SUCCESSFULLY UTILIZED
 - CUSTOMERS USING REMOTE FACILITIES OUTSIDE OF THE CONTINENTAL UNITED STATES SHOULD PROVIDE DUAL COMMUNICATIONS CAPABILITY



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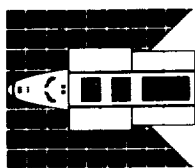
SUMMARY

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- THE PIP AND PIP ANNEXES PROVIDE THE INFORMATION REQUIRED TO SUCCESSFULLY INTEGRATE THE FLIGHT
- THROUGH THE PAYLOAD OFFICER, THE VARIOUS ANNEX MANAGERS, AND THE PAYLOAD OPERATIONS WORKING GROUP, THE CUSTOMER SHOULD EXPECT TO JOIN WITH NASA IN IMPLEMENTATION OF ALL CUSTOMER REQUIREMENTS

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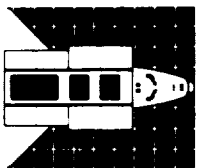


FLIGHT OPERATIONS SUPPORT ANNEX (FOSA)

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- THE FOSA PROVIDES DETAILED INFORMATION REQUIRED TO SATISFY THE FLIGHT OPERATIONS REQUIREMENTS CONTRACTED IN THE PAYLOAD INTEGRATION PLAN (PIP)
- TOPICS COVERED INCLUDE CONTROL TEAM OPERATING PHILOSOPHY, FLIGHT OPERATIONS DECISIONS, PAYLOAD OPERATING PROCEDURES, MALFUNCTION PROCEDURES, DATA COLLECTION REQUIREMENTS, AND SCHEMATICS
- INPUTS ARE IMPLEMENTED IN FLIGHT DOCUMENTATION
 - FLIGHT DATA FILE
 - CREW ACTIVITY PLAN
 - PAYLOAD DEPLOY CHECKLIST
 - PAYLOAD SYSTEMS DATA AND MALFUNCTION BOOK
 - FLIGHT RULES
 - CONSOLE DOCUMENTATION
 - OPERATIONS SUPPORT TIMELINE
 - JOINT OPERATIONS INTERFACE PROCEDURES
 - CARGO SYSTEMS MANUALS
 - RECORDER FILL AND DUMP PLANS



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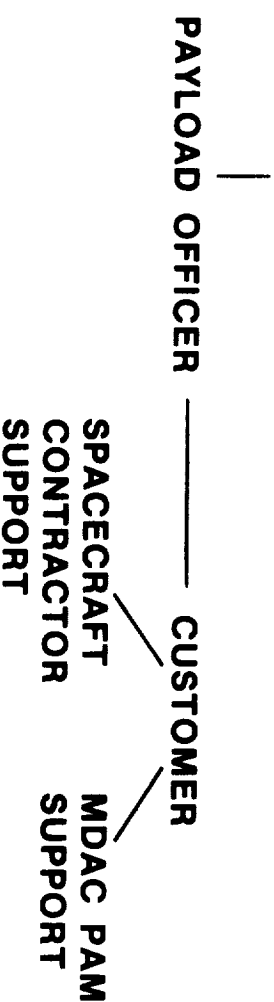
SECTION 2 -- PAYLOAD OPERATIONS SUPPORT PLAN

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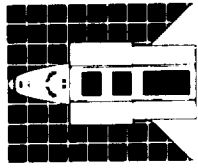
DECISION MAKING PROCESS

- THIS SECTION DETAILS THE OPERATING PHILOSOPHY OF THE GROUND SUPPORT TEAM AND IDENTIFIES THE PAYLOAD/CUSTOMER DECISION-MAKING PROCESS

EXAMPLE: FLIGHT DIRECTOR



- THIS SECTION ALSO DETAILS THE SUPPORT FACILITY REQUIREMENTS
 - LOCATION OF PAYLOAD OPERATIONS CONTROL CENTER (POCC)
 - LOCATION OF PAYLOAD REPRESENTATIVES IN MISSION CONTROL CENTER (MCC-H)
 - CONSOLE ACCOMMODATIONS
 - ACCESS TO VOICE LOOPS
- SECTION 2 IS USED FOR THE DEVELOPMENT OF SOME PORTIONS OF THE JOINT OPERATIONS INTERFACE PROCEDURES (JOIP) AND FOR FACILITY (MPSR/CSR) ALLOCATION



SECTION 3 — FLIGHT OPERATIONS DECISIONS

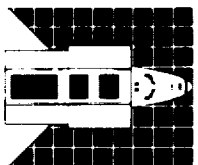
- **THIS SECTION DEFINES THE RESPONSE AND RATIONALE FOR POTENTIAL MISSION DECISION POINTS**

EXAMPLE: **SUNSHIELD FAILS TO CLOSE AFTER PAYLOAD BAY DOOR (PLBD) OPENING**

RESPONSE: **MAINTAIN BIASED -ZLV ATTITUDE AND DEPLOY PAYLOAD WITHIN TBD HOURS OF PLBD OPENING**

RATIONALE: **TYPICALLY THE TERMINAL ENVIRONMENT WITH THE SUNSHIELD OPEN WILL NOT ALLOW WAITING FOR NORMAL DEPLOYMENT NODE**

- **THIS SECTION IS USED TO DEVELOP THE FLIGHT-SPECIFIC FLIGHT RULES**



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SECTION 4 — PROCEDURES

S-84-01681

- **SECTION 4 CONTAINS PROCEDURES FOR GROUND AND ONBOARD OPERATIONS**
 - **JOINT OPERATIONS INTERFACE PROCEDURES**
 - **DETAIL ALL PROCEDURES NEEDED BY JSC AND POCC TEAMS TO COORDINATE MISSION OPERATIONS**
 - **SELECTED FROM THE JOIP SELECTION BOOK**
 - **FORM THE BASES OF THE JOIP**
 - **OPERATIONS SUPPORT TIMELINE**
 - **DOCUMENTS THE TIMES OF EXPECTED CONTROL CENTER INTERACTION. PUBLISHED AS A FLIGHT OPERATIONS SUPPORT TIMELINE**



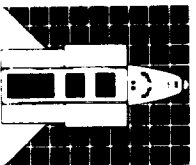
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SECTION 4 — PROCEDURES (CONT)

- **PAYLOAD PROCEDURES**
 - **PAYLOAD SYSTEM OPERATING PROCEDURES**
 - **SUNSHIELD CLOSING**
 - **PAYLOAD HEALTH CHECK**
 - **DEPLOY ACTIVITIES**
 - **MALFUNCTION PROCEDURES**
 - **PROVIDE TROUBLESHOOTING PROCEDURES FOR CREW/GROUND ANOMALY WORKAROUND**
 - **USED TO DEVELOP THE DEPLOY CHECKLIST AND PAYLOAD MALFUNCTION BOOK**
- **PAYLOAD HAZARDOUS COMMANDS**
 - **THIS SECTION DETAILS ANY CREW OR GROUND COMMANDS THAT MAY CREATE A HAZARDOUS CONDITION DURING FLIGHT. THE INTENT OF THE SECTION IS TO ASSURE ADEQUATE SAFEGUARDS ARE AVAILABLE TO PREVENT INADEQUATE HAZARDOUS COMMANDING**



SPACE
SHUTTLE
PAYLOAD

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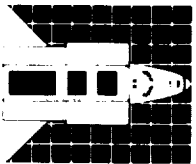
SECTION 5 — PAYLOAD DATA COLLECTION

- **SECTION 5 OUTLINES EXPECTED TIMES AND DURATIONS OF PAYLOAD DATA COLLECTION**

EXAMPLE:

ALL DEPLOY ACTIVITIES — REAL-TIME OR
RECORDED DATA CONTAINING GENERAL
PURPOSE COMPUTER (GPC) DOWNLIST
FOUR MINUTES AT BEGINNING OF DEPLOY
SEQUENCE — PAYLOAD RECORDER

- **THIS SECTION IS USED BY THE JSC FLIGHT CONTROL TEAM TO MANAGE ORBITER RECORDERS**



SPACE
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PAYLOAD

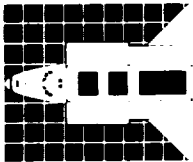
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SECTION 6 — PAYLOAD DRAWINGS

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- SECTION 6 PROVIDES FUNCTIONAL SCHEMATICS SHOWING
END-TO-END POWER, COMMANDS, AND TELEMETRY
AFFECTING SHUTTLE PAYLOAD OPERATIONS
- THIS SECTION PROVIDES OVERVIEW-LEVEL INSIGHT TO
PARAMETERS USED BY THE CREW
- IT IS USED TO DEVELOP SIMULATION MODELS, CARGO
SYSTEMS MANUALS, AND SCHEMATICS FOR PAYLOAD
MALFUNCTION BOOK



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COMMAND AND DATA ANNEX

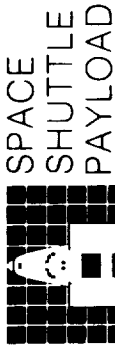
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- THE COMMAND AND DATA ANNEX IS USED BY NASA TO DEVELOP ALL OF THE SOFTWARE INTERFACES WITH THE SHUTTLE. THIS INCLUDES GENERAL PURPOSE COMPUTER (GPC) PROCESSING, PAYLOAD DATA INTERLEAVER (PDI) FORMAT DATA AND MULTIPLEXER/DEMULTIPLEXER (MDM) CHANNELIZATION. THESE DATA WILL BE USED TO DEVELOP SEVERAL SOFTWARE PRODUCTS THAT WILL SUPPORT PRELAUNCH TESTING, SIMULATIONS, AND THE FLIGHT. THE PURPOSE OF THIS PRESENTATION IS TO DESCRIBE THE IMPLEMENTATION PROCESS FOR THESE PRODUCTS

● **TABLE 1 — PAYLOAD DATA REQUIREMENTS**

THIS TABLE IS USED AS THE PRIMARY LISTING OF ALL PARAMETERS THAT WILL BE DISPLAYED BY THE STS. DATA PROVIDED INCLUDE NOMENCLATURES, ID NUMBER, UNITS, RANGE, DATA TYPE, DATA LENGTH, RESPONSE RATE, FLIGHT OR GROUND APPLICABILITY, ONBOARD DISPLAY APPLICABILITY, FAULT DETECTION APPLICABILITY, AND REQUIRED FLIGHT PHASE. THE DATA IN THIS TABLE WILL BE USED TO DEVELOP THE ONBOARD DISPLAYS, ANY MISSION CONTROL CENTER (MCC) DISPLAYS, AND ANY LAUNCH PROCESSING SYSTEM (LPS) DISPLAYS



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ANNEX DESCRIPTION (CONT)

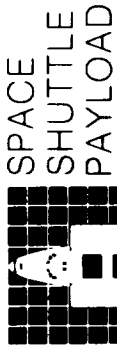
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● TABLE 2 — PAYLOAD MANAGEMENT FAULT DETECTION AND ANNUNCIATION

THIS TABLE IS USED TO SPECIFY THE PARAMETERS THAT ARE TO BE LIMIT-SENSED BY THE ORBITER'S FAULT DETECTION AND ANNUNCIATION (FDA) SYSTEM. TABLE 2 MUST BE USED IN CONJUNCTION WITH TABLE 3 (PRECONDITION STEERING) TO TOTALLY DEFINE THE FDA SCHEME. TABLE 2 SPECIFIES THE PARAMETERS AND THE ALLOWABLE LIMITS FOR UP TO THREE SETS OF CONDITIONS

**● TABLE 3 — PAYLOAD MANAGEMENT PRECONDITION
STEERING**

TABLE 3 IS USED TO STATE THE PARAMETERS AND THEIR PROPER STATES, WHICH DEFINE A SET OF CONDITIONS DEFINING WHEN A PARAMETER SHOULD BE ALARMED. AS AN EXAMPLE, A PARAMETER THAT IS ONLY VALID WHEN A TELEMETRY ENCODER IS POWERED MAY USE THE ENCODER ON/OFF TALKBACK AS A PRECONDITION. GENERALLY THE CUSTOMER SHOULD PROVIDE A FIRST ESTIMATE OF THE PARAMETERS THAT ARE TO BE LIMIT-SENSED AND THEIR VALUES. JSC WILL DEVELOP A PRELIMINARY DRAFT OF THE PRECONDITION STEERING. THIS LOGIC WILL THEN BE REVIEWED BY THE CUSTOMERS



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ANNEX DESCRIPTION (CONT)

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● TABLE 4 — PAYLOAD MEASUREMENT MANAGEMENT

TABLE 4 IS USED TO SPECIFY SCALING COEFFICIENTS FOR ALL THE ANALOG MEASUREMENTS TO BE PROCESSED BY THE STS. THIS TABLE WILL BE USED TO DEVELOP THE ONBOARD DISPLAYS AND GROUND DISPLAYS

● TABLE 5 — PDI DECOMMUTATION FORMAT SUMMARY

TABLE 5 PROVIDES OVERVIEW INFORMATION CONCERNING THE PAYLOAD PDI DATA STREAM CHARACTERISTICS

● TABLE 6 — FORMAT DECOMMUTATION CHARACTERISTICS

TABLE 6 PROVIDES DETAILED INFORMATION DEFINING THE PDI FORMAT CHARACTERISTICS

ANNEX DESCRIPTION (CONT)

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● **TABLE 7 — PAYLOAD TELEMETRY FORMAT REQUIREMENTS**

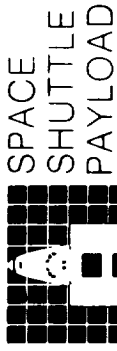
TABLE 7 IDENTIFIES THE CHANNELIZATION FOR EACH PAYLOAD PARAMETER AND DEFINES WHICH ORBITER TELEMETRY FORMATS CONTAIN EACH PARAMETER

● **TABLE 8 — FORMAT DESCRIPTIONS**

TABLE 8 IS A LISTING BY ORBITER FORMAT OF ALL THE PAYLOAD PARAMETERS IN EACH FORMAT

● **TABLE 9 — PAYLOAD COMMAND DATA REQUIREMENTS**

TABLE 9 IS A LISTING OF ALL COMMANDS REQUIRED THROUGH THE ORBITER GPC. THIS TABLE IS OF A SUMMARY NATURE, INDICATING COMMAND TYPES AND THE NUMBER OF WORDS IN EACH COMMAND. TABLE 9 ALSO DEFINES ANY MCC PRESTORED COMMANDS



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ANNEX DESCRIPTION (CONT)

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- **TABLE 10 — PAYLOAD COMMAND DATA, COMMAND CHANNELIZATION, AND DEFINITION**

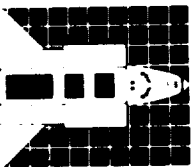
TABLE 10 PROVIDES THE DETAILED CHANNELIZATION FOR ALL THE COMMANDS PREVIOUSLY LISTED IN TABLE 9. THIS TABLE WILL ALSO DEFINE COMMAND NUMBERS FOR ANY COMMANDS THAT ARE STORED PREMISSION IN THE MCC

- **TABLE 11 — PAYLOAD COMMAND LOADS**

TABLE 11 PROVIDES THE DETAILED COMMAND WORDS AND COMMAND TYPE FOR ALL PRESTORED ONBOARD OR MCC COMMANDS

- **TABLE 12 — PAYLOAD MULTIPLE COMMANDS**

TABLE 12 PROVIDES DETAILED DATA DEFINING MULTIPLE COMMANDS THAT ARE TO BE ISSUED FROM THE MCC



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PAYLOAD

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ANNEX DESCRIPTION (CONT)

● TABLE 13 — PAYLOAD BUILDABLE COMMANDS

TABLE 13 PROVIDES THE DETAILED DATA FOR COMMANDS THAT CAN BE BUILT IN REAL TIME AND ISSUED FROM THE MCC

● TABLE 14 — PAYLOAD ANALOG COMMAND CALIBRATION

TABLE 14 PROVIDES THE DETAILED DATA FOR ONBOARD ANALOG COMMANDS

● TABLE 15 — IDENTIFICATION REFERENCE TABLE

TABLE 15 PROVIDES A CROSS REFERENCE OF RELATED ID NUMBERS/NOMENCLATURE TO PAYLOAD DATA OR COMMAND M/S ID'S. THE DSM (MCC COMMAND) OPERATIONAL NOMENCLATURE IS DEFINED IN THIS TABLE



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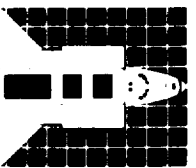
ANNEX DESCRIPTION (CONT)

● TABLE 16 — PSP CONFIGURATION DATA

TABLE 16 PROVIDES ALL THE NECESSARY DATA FOR PAYLOADS THAT REQUIRE THE PAYLOAD SIGNAL PROCESSOR (PSP) FOR COMMANDING, TYPICALLY IN A DEPLOYED RF MODE

● TABLE 17 — BTU/SSI ASSIGNMENT DATA

TABLE 17 PROVIDES DETAILS OF THE BTU/MIA/SSI ASSIGNMENTS FOR THIS PAYLOAD



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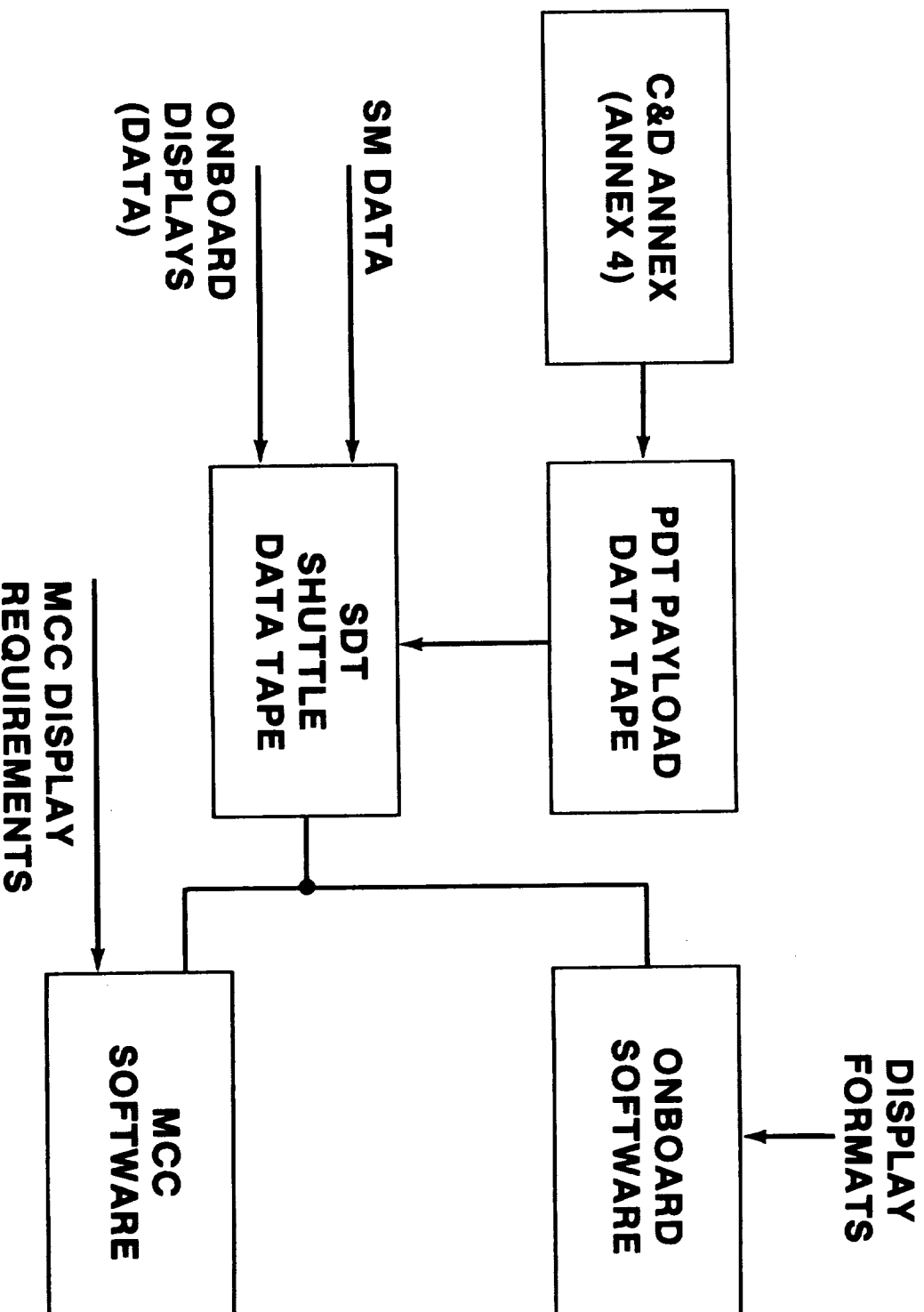


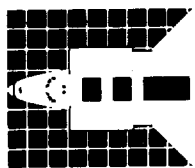
PAYLOAD SOFTWARE DEVELOPMENT

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- **THE ENTIRE PAYLOAD SOFTWARE DEVELOPMENT PROCESS MAY BE SIMPLIFIED INTO A FEW STEPS**
 - **THE COMMAND AND DATA ANNEXES FOR ALL PAYLOADS ON A FLIGHT ARE USED TO GENERATE A COMBINED PAYLOAD DATA TAPE (PDT) FOR EACH FLIGHT**
 - **THE PAYLOAD DATA TAPE IS COMBINED WITH THE ORBITER DATA AND DISPLAY REQUIREMENTS TO FORM THE SHUTTLE DATA TAPE (SDT)**
 - **THE SHUTTLE DATA TAPE THEN FORMS THE BASIS FOR BOTH THE ONBOARD SOFTWARE AND THE MCC SOFTWARE**

PAYLOAD SOFTWARE DEVELOPMENT





SUMMARY

- THE COMMAND AND DATA ANNEX IS USED TO DEVELOP SEVERAL KEY PRODUCTS. MUCH OF THE DATA CONTAINED IN THE ANNEX MUST BE SUPPLIED BY NASA/JSC; HOWEVER, GOOD COORDINATION AMONG THE CUSTOMER, ANNEX MANAGER, AND PAYLOAD OFFICER WILL HELP ENSURE THAT ALL OF THE REQUIRED DATA IS DOCUMENTED

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